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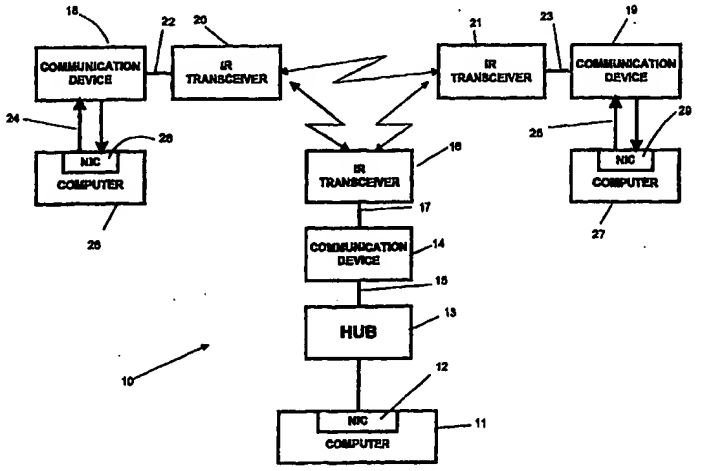

(57) Abstract

A method and system for avoiding collision between data streams transmitted by at least a pair of wireless transmitters (16, 20, 21) operating on substantially equal frequencies and coupled via respective communication channels (17, 22, 23) to respective communication devices (14, 18, 19) having associated therewith respective carrier sense means (12, 28, 29) which are responsive to a signal received thereby for preventing the respective communication device from initiating or continuing transmission of data. According to the method whenever data is wireless transmitted by one of the transmitters, said one of the transmitters sending a fictitious data signal along the respective communication channel so as to be detected by the respective carrier sense means.

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Method and system for avoiding collisions in an Infra-Red wireless network

FIELD OF THE INVENTION

This invention relates to wireless transmission within or between Local Area Networks (LANs) and, in particular, to an improved method of collision avoidance of data in such LANs.

BACKGROUND OF THE INVENTION

LANs employing non-wireless communication channels typically comprise a communication device in the form of a computer terminal connected to other communication devices by a twisted wire or coax or multi-core cable. In each communication device there is provided a suitable Network Interface Card (NIC) which operates in accordance with a network protocol for allowing different terminals to communicate with one another.

Various network protocols are known such as, for example, Ethernet, which not only control the manner in which data is transmitted from one terminal to another but also provide what is known as "collision detection" which detects the substantially simultaneous transmission of data from two or more network terminals.

Such collision detection is beneficial, because it permits near simultaneous transmission of data packets from two or more terminals to be aborted almost immediately when only a small fraction of the data packet has been transmitted. Were such collision detection not to be provided, then the whole of the data packet would be transmitted by each of the conflicting terminals and only then would the error checking algorithms, which are themselves an integral feature of the network protocol, detect that the received data was corrupt. This would then require controlled re-transmission of the data by each of the conflicting terminals in such a manner as to ensure that no two terminals attempted to transmit simultaneously. The manner in which this is done is well known to those skilled in the art and thus needs no further elaboration.

It is important to understand that the collision detection which is provided as part of the network protocol has no way of actually preventing data collision. All it can do is to detect that two or more terminals are transmitting simultaneously and abort all of the transmissions before a complete data packet is transmitted. This saves time and, of course, energy. The remedial action which is then taken, as well as its particular implementation, depends on the network protocol employed.

The ability to detect collisions of data packets transmitted by different terminals in a LAN wherein the communication devices (terminals) are interconnected via wires, is a consequence of such LANs operating "full duplex". In other words, a communication device is able both to send and receive data at the same time. Consequently, a transmitting terminal is nevertheless able to receive data transmitted by a competing terminal and the network protocol is then able to detect the resulting data collision and take appropriate remedial action.

In wireless communication, full duplex data transmission is not possible unless different frequencies are employed to transmit and receive

data so that different broadcast channels can be employed for data transmission and reception, respectively. Increasingly, wireless transmission is being effected using infra-red communication which operates on the same principles as radio transmission in that electromagnetic waves are employed, but only a very narrow part of the electromagnetic spectrum is employed. To all intents and purposes, the frequency of all infra-red transmissions can be considered equal. As a result, full duplex transmission using IR is not possible and, therefore, once data has been transmitted through the air by an IR transmitter, there is no way during the actual act of data transmission that the IR transmitter can know about a conflicting IR transmitter sending data simultaneously.

Owing to this inability of IR transmitters to detect data collisions, it is normal practice to employ sophisticated data communications protocols which detect that data received by a terminal is corrupt and then require that the transmitting terminal re-transmit the corrupted data packet in a controlled manner so as to avoid further collisions. This is wasteful of both time and energy. Thus, specifically, if a data packet contains 1,500 bytes of data which are transmitted in 1.5 ms, then seeing that all of the data packet must be transmitted in its entirety before the receiving software can determine that it has been received corruptly, no remedial action can be taken for at least 1.5 ms, whereupon the whole data packet must, of course, be re-transmitted in its entirety. On the other hand, with conventional wired LANs having collision detection hardware, a data collision can be detected typically within one or two bits of data so that the transmission of the complete packet may then be interrupted after no more than 200 ns. This is, of course, a very substantial saving in wasted time. Furthermore, since data transmission requires energy, being able to abort the data transmission when only a very small fraction of the data packet has been transmitted, also saves energy; and

this is particularly significant when portable, battery-powered IR transmitters are employed.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a method for avoiding collision between data streams transmitted by at least two IR transmitters which are coupled via respective cables to a conventional LAN.

According to a broad aspect of the invention, there is provided a method for avoiding collision between data streams transmitted by at least a pair of wireless transmitters operating on substantially equal frequencies and coupled via respective communication channels to respective communication devices having associated therewith respective carrier sense means which are responsive to a signal received thereby for preventing the respective communication device from initiating or continuing transmission of data, the method comprising the steps of:

whenever data is wireless transmitted by one of the transmitters, said one of the transmitters sending a fictitious data signal along the respective communication channel so as to be detected by the respective carrier sense means.

Preferably, the carrier sense means comprises a conventional Network Interface Card (NIC) which is, in any case, provided as an integral part of the LAN. In such case, the provision of the NIC is exploited by the method according to the invention in order to "deceive" the receiving terminal into believing that a conventional data transmission was initiated by another terminal in the LAN.

The invention exploits the Carrier Sense Multiple Access (CSMA) protocol in which collision avoidance is implemented in the Ethernet network and other networks having similar protocols. Before transmitting, each transmitter establishes that no transmission has been in progress for at least a

minimum time interval, typically 9.6 μs. Only after this time interval has elapsed in the absence of any network activity, is a transmitter permitted to initiate a new transmission. In the method according to the invention, after this time interval has elapsed, the wireless IR LAN starts to transmit fictitious data to the NIC and thus ensures collision avoidance. Specifically, the terminal containing the NIC is deceived into interpreting the received fictitious data as regular network activity and is thus prevented from initiating its own transmission.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how the same may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, and with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram showing functionally a system for carrying out the method of the invention; and

Fig. 2 shows part of a timing diagram assuming the use of the Ethernet communications protocol for use with the system illustrated in Fig. 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Fig. 1 shows an infra-red LAN designated generally as 10, comprising a computer 11 operating as a network server containing therein a Network Interface Card (NIC) 12. The computer 11 is coupled via a HUB 13 to a first communication device 14 by means of a 10 Base-T (twisted pair) cable 15 constituting a communication channel. The HUB 13 is a wired distribution box allowing routing to other communication devices in the system. A first IR transceiver 16 is coupled to the first communication device 14 by a cable 17 which also constitutes a communication channel. The first IR transceiver 16 allows the first communication device 14 to communicate

via wireless communication with second and third communication devices 18 and 19, respectively. To this end, there are connected to the second and third communication devices 18 and 19, corresponding second and third IR transceivers 20 and 21 via respective 10 Base-T (twisted pair) cables 22 and 23 which also constitute communication channels. Likewise, there are connected to the second and third communication devices 18 and 19, via respective 10 Base-T (twisted pair) cables 24 and 25 which also constitute communication channels, corresponding second and third computers 26 and 27 containing therein respective Network Interface Cards (NIC) 28 and 29.

When one of the communication devices 14, 18 or 19 receives a communication from one of the other communication devices in the LAN, the resulting signal passes along the adjacent communication channel 15, 24 and 25 so as to be received by the NICs 12, 28 and 29 in each of the computers 11, 26 and 27 which then acts, in known manner, to prevent the respective communication device 14, 18 and 19 from initiating a communication. By such means, overlapping communications between different communication devices in the LAN 10 is prevented.

When one of the IR transceivers, for example the first IR transceiver 16, initiates a communication, a fictitious data signal is sent along the respective communication channel 17 so as to be received the NIC 12 in the respective computer 12 in the LAN 10. The NIC 12 ensures that the computer 12 does not attempt to initiate further communication until the IR transceiver 16 has terminated its transmission. Upon such termination, discrete, non-overlapping time slots are randomly selected by each of the IR transceivers 16, 17 and 18 so that no two IR transceivers will attempt to initiate a communication simultaneously. Such simultaneous initiation of a data communication by the IR transceivers must be prevented because, as explained above, an IR transceiver which is engaged in data transmission has no way of detecting that another IR transceiver in the LAN 10 has also,

simultaneously, initiated a data transmission. Thus, by virtue of the random time delay selected by each NIC which wants to initiate transmission, the likelihood of two or more IR Transceivers attempting to initiate a communication simultaneously is significantly reduced.

Fig. 2 shows a detail of a timing diagram assuming the use of the Ethernet communications protocol in the wired communication channels of the LAN 10. IR data is transmitted by a station transmitter Tx in packets, as shown at 30. At the end of each data packet 30, each station receiver Rx waits for a period of dead time Δt and then selects a random time slot for initiating communication. The dead time Δt is a feature of the Ethernet protocol and merely provides for a minimal inter-frame time gap. In order to ensure that during the time interval following the end of one data packet until the initiation of the next data packet, none of the communication devices attempts to initiate its own communication, fictitious data is sent to each of the NICs by the corresponding station transmitter Tx. The fictitious data is interpreted by the receiving NIC as a regular wired data transfer through the 10 Base-T (twisted pair) cable communication channel. As a result, in order to avoid collisions, the NIC acts to prevent the communication channel from initiating further communication. By such means wireless communication can be implemented without the danger of collision from wired data transmission through the LAN 10; whilst the random allocation of time slots for the wireless data transfer likewise serves to reduce the likelihood of data collisions during IR data transmission.

Furthermore, because the invention obviates the need for protocol conversion and verification, wireless data received by the communications device may be forwarded on the fly to a destination computer containing a NIC card, without the need for buffering and processing. This results in faster and less expensive data transfer.

CLAIMS:

1. A method for avoiding collision between data streams transmitted by at least a pair of wireless transmitters (16, 20, 21) operating on substantially equal frequencies and coupled via respective communication channels (17, 22, 23) to respective communication devices (14, 18, 19) having associated therewith respective carrier sense means (12, 28, 29) which are responsive to a signal received thereby for preventing the respective communication device from initiating or continuing transmission of data, the method comprising the step of:

whenever data is wireless transmitted by one of the transmitters, said one of the transmitters sending a fictitious data signal along the respective communication channel so as to be detected by the respective carrier sense means.

2. The method according to Claim 1, wherein the wireless transmitters are infra-red transmitters (16, 20, 21).

3. The method according to Claim 1 or 2, wherein the carrier sense means (12, 28, 29) comprises a Network Interface Card (NIC) containing therein a carrier sense and anti-collision protocol.

4. The method according to any one of the preceding claims, further including the step of allocating a random time slot to each of the wireless transmitters for initiating a data transmission therein so as to reduce a probability of two transmitters starting to transmit simultaneously.

5. An infra-red LAN (10) comprising at least a pair of IR transmitters (16, 20, 21) coupled via respective communication channels (17, 22, 23) to respective communication devices (14, 18, 19) having associated therewith respective carrier sense means (12, 28, 29) which are responsive to a signal received thereby for preventing the respective communication device from initiating or continuing transmission of data, each of the IR transmitters being

programmed to carry out the collision avoidance method of any one of the preceding claims.

6. The infra-red LAN according to Claim 5, wherein at least one of the communication devices is a network HUB (13).

7. The infra-red LAN according to Claim 5 or 6, wherein at least one of the communication devices is a computer (11, 26, 27) containing a network card (12, 28, 29) therein.

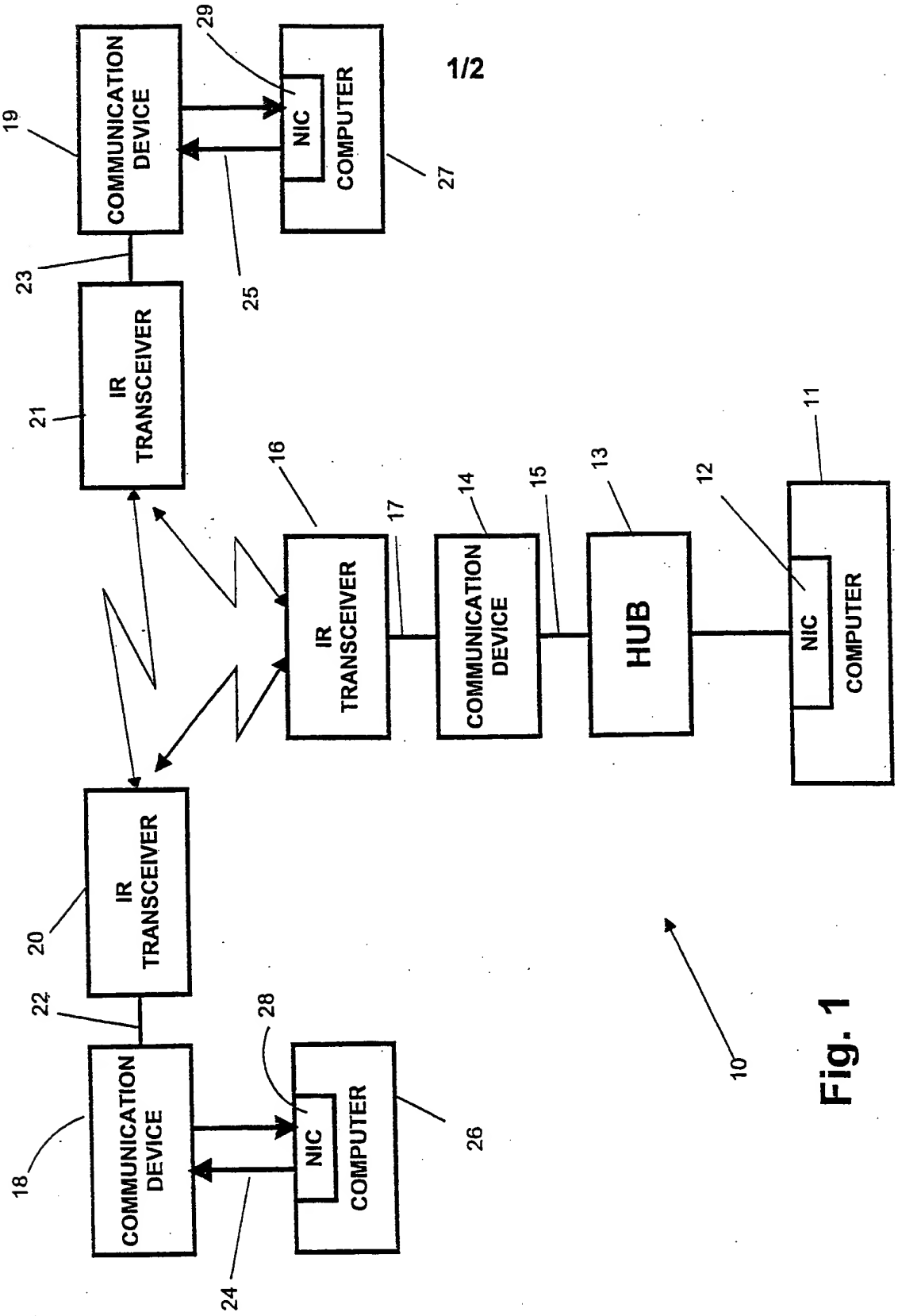
COMMUNICATION DEVICE
19
29
NIC
COMPUTER
27
23
25
IR TRANSCEIVER
21
16
17
14
15
13
12
11
IR TRANSCEIVER
COMMUNICATION DEVICE
HUB
NIC
COMPUTER
20
22
28
10
COMMUNICATION DEVICE
18
NIC
COMPUTER
26
24

Fig. 1

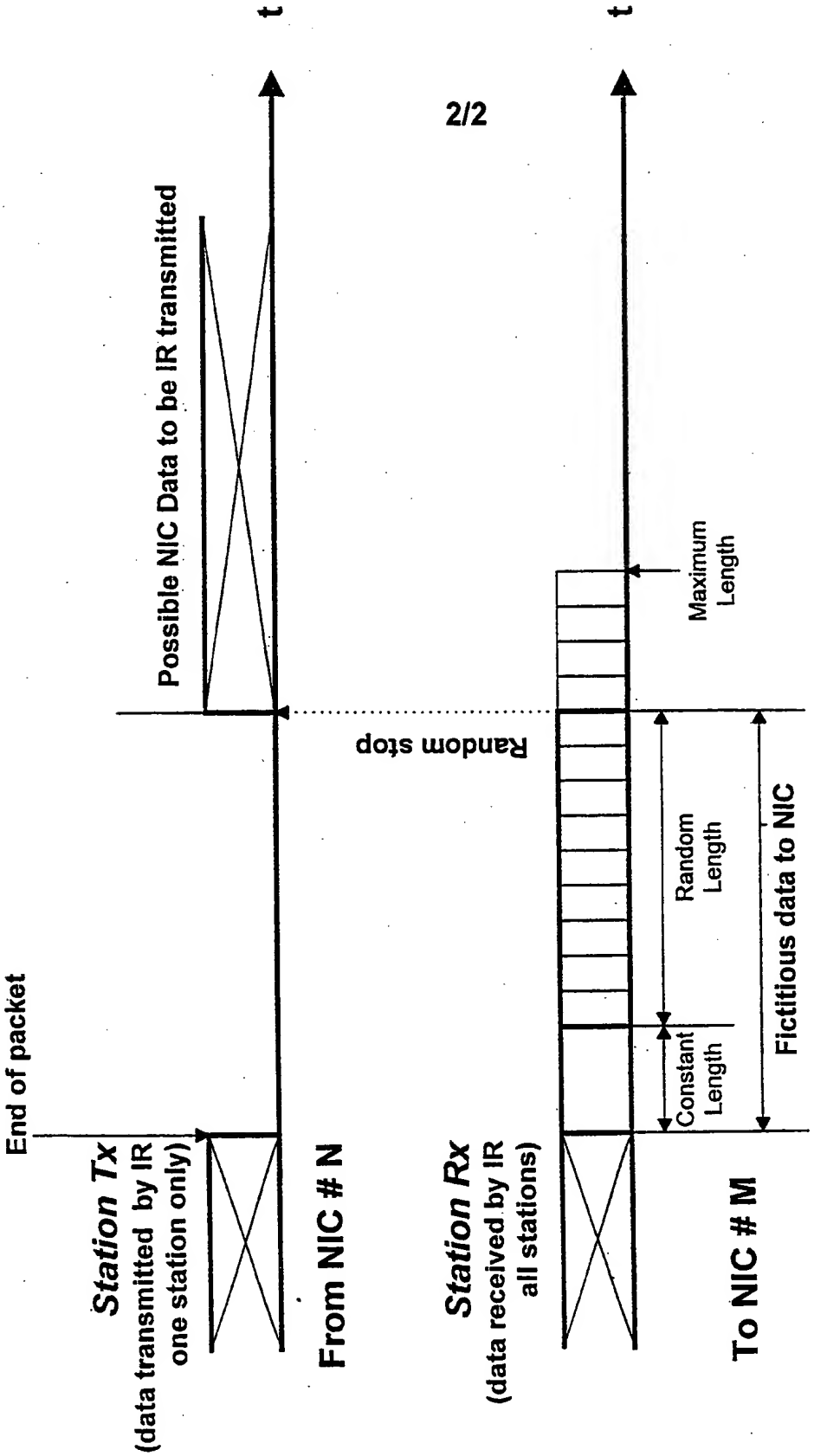
t
t
Possible NIC Data to be IR transmitted
Random stop
Maximum Length
Random Length
Constant Length
Fictitious data to NIC
End of packet
Station Tx
(data transmitted by IR one station only)
From NIC # N
Station Rx
(data received by IR all stations)
To NIC # M

Fig. 2

INTERNATIONAL SEARCH REPORT

Internatic Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L12/28 H04L12/413 H04B7/26

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B. FIELDS SEARCHED

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Documentation searched other than minimumdocumentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 475 682 A (NCR CO) 18 March 1992 see column 2, line 8 - line 53 see column 7, line 51 - column 8, line 44 see column 9, line 45 - line 50	1-5,7
A	---	6
Y	WO 96 19877 A (3COM CORP) 27 June 1996 see page 13, line 31 - page 14, line 22	1-5,7
A	--- "STANDARD PC-NET ADAPTER AND SOFTWARE CSMA OR CSMA/CA ON NON-TRADITIONAL MEDIA" IBM TECHNICAL DISCLOSURE BULLETIN, vol. 35, no. 3, 1 August 1992, pages 105-108, XP000326192 see the whole document	1-7
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Date of the actual completion of theinternational search	Date of mailing of the international search report
19 October 1998	27/10/1998

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 96 21978 A (MOMENTUM MICROSYSTEMS ;LANSFORD JAMES L (US); MUECKE MICHAEL L (US) 18 July 1996 see page 4, line 10 - page 5, line 5 see page 8, line 24 - line 37 see page 10, line 18 - page 12, line 5	1-7

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0475682 A	18-03-1992	DE 69126266 D	03-07-1997
		DE 69126266 T	02-01-1998
		JP 6029978 A	04-02-1994
		US 5369639 A	29-11-1994
WO 9619877 A	27-06-1996	US 5657326 A	12-08-1997
		AU 4603996 A	10-07-1996
		GB 2310978 A	10-09-1997
WO 9621978 A	18-07-1996	EP 0803152 A	29-10-1997